GROUNDWATER ARSENIC CONTAMINATION AND ITS DISTRIBUTION IN KATIHAR DISTRICT IN BIHAR

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Abstract : The incidence of arsenic contamination of ground water used for both irrigation as well as for human consumption or industrial activities has taken the dimension of an epidemiological problem. It has been established that inorganic arsenic is extremely toxic both acute and chronic. Arsenic (As) is one of the hazardous elements found in the environment. Arsenic contamination of groundwater is reported worldwide and, in the Katihar district, in particular. Groundwater is a major source of water for drinking, domestic and agriculture purposes. However, in some parts of this region, the quality of groundwater is questionable due to arsenic contamination. The main objective of this study is to demark the extent of the As-contaminated area in the Katihar district. This study will help for better planning and management of groundwater in the study region.

Keywords : Arsenic, Ground water, Drinking water, contaminations, Katihar.

Introduction

Arsenic is an element that raises much concern from the both environmental and human health standpoints. Humans may encounter arsenic in water from wells drilled into arsenic-rich ground strata or in water contaminated by industrial or agrochemical waste. (Huang et.al., 1985) They may come in contact with arsenic in contaminated dusts, fumes, or mists. They may eat food contaminated with arsenical pesticides or grown with arsenic-contaminated water or in arsenic-rich soil. (Nriagu and Azcue, 1990)

Groundwater contains wide variety of dissolved inorganic chemical constituents in various concentrations, resulting from chemical and biochemical interactions between water and the geologic materials. Some regions of various states of India are arsenic in ground water is generally reported to be geogenic. Arsenic in ground water beyond the BIS acceptable and permissible limit of 10 and 50 ppb respectively has been reported from many states namely West Bengal, Bihar, Uttar Pradesh, Assam, Manipur, Jharkhand, Punjab, Haryana, Chhattisgarh and Karnataka etc. (CGWB, 2015)

In Bihar, arsenic in groundwater was first discovered in 2002 in two villages (Semariya-Ojhapatti and Doodhghat) in the Bhojpur District, which exceeded 50 ∝g/L (Chakraborti et al. 2003). Consequently, CGWB carried out detailed survey and encountered maximum Arsenic concentration of 178 µg/L and Hand pumps with medium depth (20–35 mbgl) are mostly affected (Saha et al. 2009). However, dug wells with shallow depth (< 8 m) are free from Arsenic contamination. In addition, they reported that aquifer below 80m is free from Arsenic and maximum concentration (62 µg/L) was recorded at 19 m depth at Bariswan village. Nickson et al. (2007) studied the Arsenic contamination in groundwater of 50 blocks in 11 districts of Bihar. They found that 12,097 samples out of 66,623 samples tested had Arsenic between 10 and 50 µg/L and 7,164 samples exceeded As > 50 µg/L.

Arsenic distribution

Arsenic is found in the natural environment in abundance in the Earth's crust and in small quantities in rock, soil, water and air. Arsenic in ground water have a considerable significance due to their toxicity and adsorption behavior. Despite the presence of trace concentrations of Arsenic in the aquatic environment, which is essential to a number of life processes, high concentrations of Arsenic become toxic. The major sources of Arsenic in ground and surface water include weathering of rock minerals, discharge of sewage and other waste effluents on land and runoff water.

Materials and Methods

Study area

Katihar district is situated in Bihar state and it is one of the thirty-eight districts of Bihar state and its administrative headquarter is located in Katihar town. The total geographical area of Katihar district is 2395 km2. Katihar district falls within 25°32'15"N and 87°33'58"E. The district area is surrounded by Purnea and Bhagalpur district of Bihar in north and west respectively, Sahebganj district (Jharkhand) in south and Malda district and Uttar Dinajpur district (West Bengal) in East. The total population around 240,838 (Census 2011). The competitive advantage of Katihar lies in its good rail and road connectivity with the surrounding region and also other parts of the country which gives it the potential to be developed as logistics hub. Katihar is located very close to the River Kosi that is well known for its floods and the saucer shaped topography of the city makes it prone to water logging. The district comprises 3 Sub-Divisions : Katihar, Barsoi and Manihar. Katihar sub-division consists 10 blocks : Katihar, Korha, Falka, Sameli, Barari, Kursela, Pranpur, Hasanganj, Dandkhora and Mansahi. Barsoi sub-division consists 4 blocks : Barsoi, Kadwa, Azamnagar and Balrampur and Manihari sub-division has 2 blocks : Manihari and Amdabad.

MATERIALS AND METHODS

The study was undertaken in four blocks of Katihar district to analyse the arsenic contamination in different drinking water sources from March 2017 to February 2018. Altogether 15 villages from three blocks Katihar, Amdabad and Barari were selected for detailed study. The drinking water sources used by the people in these villages, *e.g.* tube wells, dug wells, railway supply, municipal supply and river Ganga were selected for detailed analyses. The groundwater testing was done initially by field test kit (Colorimetrique avec bandle test) and then confirmed by U.V. Spectrophotometric method (Photo lab 6600 UV-VIS series).

Results and Discussion

Total 45 groundwater samples were collected from the Katihar District, Bihar. The samples were analysed for trace Arsenic for which analytical results of the chemical analysis are summarised and given in Table 1.

High prevalence of arsenic contamination in ground water was found after analysis of 45 water samples. The different strips showed different patterns of arsenic contamination in ground water. All the seven strips showed a unique pattern of arsenic

contamination in the groundwater as the middle region of the strips were arsenic free, but their periphery showed severe arsenic contamination in the hand pumps. Among the most severely affected blocks were Barari and Manihari where the arsenic contamination was much higher in most of the analyzed water samples. The Barari block showed hand pumps with arsenic contamination average above 80 ppb while Manihari block showed handpumps with arsenic contamination average above 60 ppb. (Table 1)

Table 1: Comparative analysis between distance from river Ganga to different strips of Simri village, average arsenic concentration in groundwater in strips and average depth of hand pumps (analysis of variance test)

Blocks	Average Arsenic concentration in groundwater in blocks (ppb)
Barari	80.20
Amdabad	48.31
Katihar	28.25
Manihari	60.49

Discussion

In Bihar, the similar trend in the ground water was firstly reported in 2002 in Katihar district (Chakraborti, et.al., 2003) and then after, the number has increased to 16 districts. (Singh et.al., 2014) The most of the arsenic affected area in the district Katihar is similar pattern in Bihar also. The utilization of digging hand pumps in every household eventually started in Bihar in the late 1980s. But, due to the immense utilization of ground water for agricultural practices in the 1990s caused lot of damage at the geological level in the Gangetic plains. This in turn led to the lowering down of the water table in summer season causing oxygen to reach into the aquifers.

In this study, the groundwater assessment in Katihar district is the novel work ever done in this field. The population is high in uplands where new alluvium containing arsenopyrite is less and these point bars are insulated by alternating clay plugs which blocks arsenic mobilization from other point bars where arsenopyrite arsenic is higher. It is also interpreted that a free-moving groundwater flux is present in the highly permeable gravel and gravelly sand below the sequence boundary. The flux effectively flushes the permeable sediment, hence, the low-arsenic concentration. Arsenic-enriched water that percolates downward from the point-bar sand to the sequence boundary accumulates at the top of the free-moving groundwater flux; hence, the peak in arsenic concentration. (Donselaar et.al., 2003) The second most important finding also deciphers that the block which are closer to the river Ganga especially Amdabad and Manihari are having low concentrations of arsenic in the groundwater but the strips which are far away from the river Ganga such as Katihar block is having higher concentrations of arsenic in the groundwater. The reason behind is that the village islocated near river Ganga in oxbow lake area, formed due to meandering of river. Such area has an alternating point bars and clay plugs. Usually, the population is high in uplands where new alluvium containing arsenopyrite is less, and these point bars are insulated by alternating clay plugs which blocks arsenic mobilization from other point bars where arsenopyrite arsenic is higher. It is also interpreted that a free-moving groundwater flux is present in the highly permeable gravel and gravelly sand below the sequence boundary. The flux effectively flushes the permeable sediment, hence the low-arsenic concentration. Arsenic-enriched water that percolates downward from the point-bar sand to the sequence boundary accumulates at the top of the free-moving groundwater flux; hence, the peak in arsenic concentration. (Donselaar et.al., 2003)

Among the analysed samples about 15% samples showed marginally elevated Arsenic (ranging between 10-25 µg/L) concentration in the Katiahr district, whereas about 29% and 21% of the analysed samples were in the range of 25-50 µg/L and above 50 µg/L respectively in the study area.

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